

REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 1 to delete from the preamble thereof the expression "for polishing an inorganic insulating film having unevenness on a surface thereof"; and have further amended claim 1 to recite, in a "wherein" clause, that the abrasive is capable of being used in forming shallow trench isolation, and is adapted to polish an inorganic insulating film having unevenness on a surface thereof. Applicants have amended preambles of each of the previously considered claims, in light of amendments to claim 1; and have amended claim 6 to recite the sedimentation speed of "the" cerium oxide particles.

Moreover, Applicants are adding new claims 30-34 to the application. Claim 30, dependent on claim 1, defines an average particle diameter of the cerium oxide particles; and claims 31 and 32, each dependent on claim 1, respectively recite that the organic polymer is selected from a specified group of materials. Claims 33 and 34, each dependent on claim 1, respectively recites that the CMP abrasive is adapted to polish an oxide insulating film having unevenness on a surface thereof, and recites that the CMP abrasive is adapted to polish a silicon oxide film having unevenness on a surface thereof.

In connection with the newly added claims, as well as in connection with amendments to previously considered claims, note, for example, pages 2, 3, 8, 9, 11, and Example 2 on pages 18-21, of Applicants' specification.

The objection to claim 6 as set forth in Item 2 on page 2 of the Office Action mailed September 11, 2006, is moot, in light of present amendments to claim 6 to recite "the" cerium oxide particles.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teaching of the prior art applied by the Examiner in rejecting claims in the Office Action mailed September 11, 2006, that is, the teachings of United States Patent Application Publication No. 2003/0181046 A1 to Sachan, et al., and Japanese Patent Document No. 10-102040, under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that the references as applied by the Examiner would have neither taught nor would have suggested such a CMP abrasive as in the present claims, "consisting essentially of" the components recited in claim 1, including the organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of the insulating film to be polished, and wherein the organic polymer is a compound containing at least one atom having an unpaired electron in a molecular structure, and the abrasive has properties of being capable of being used in forming shallow trench isolation, and being adapted to polish an inorganic insulating film having unevenness on a surface thereof. See claim 1.

As will be discussed further infra, present claim 1 defines properties of the CMP abrasive, in being capable of being used in a specified procedure and being adapted to polish a specified film, and it is respectfully submitted that the teachings of the applied prior art would have neither taught nor would have suggested such abrasive having the recited properties, as set forth in the present claims.

More specifically, it is respectfully submitted that these applied references would have neither taught nor would have suggested such CMP abrasive, having features as discussed previously in connection with claim 1, and, more specifically,

wherein the abrasive is adapted to polish an oxide insulating film (see claim 33), even more specifically, a silicon oxide film (see claim 34).

Furthermore, it is respectfully submitted that the applied references would have neither disclosed nor would have suggested such CMP abrasive for polishing inorganic insulating films having unevenness on a surface thereof as in the present claims, having features as discussed previously in connection with claim 1, and, in addition, wherein the abrasive "consists of" the recited components (see claim 29); and/or wherein the organic polymer is a compound containing either one or both of nitrogen atom and oxygen atom in the molecular structure (see claim 3); and/or wherein this organic polymer is a compound having an adsorption ratio of at least 50% with respect to silicon oxide particles (see claim 4) or an adsorption ratio of at least 40% with respect to silicon nitride particles (see claim 5), where such particles of a specific surface area are dispersed in water of a specific pH; and/or wherein the organic polymer is a specific material or selected from a specific group of materials (as in claims 7, 31 and 32), having a weight average molecular weight as in claim 8; and/or wherein the organic polymer is included in the abrasive in an amount as in claim 28, or amount of dispersant, organic polymer, water and cerium oxide particles as in claim 9; and/or further definition of the dispersant as in claim 27; and/or average particle diameter of the cerium oxide particles (see claim 30), or sedimentation speed of the cerium oxide particles (see claim 6).

The invention being considered on the merits in the above-identified application relates to a CMP abrasive, used in smoothing a surface of an inorganic insulating film (e.g., an insulating film filling shallow trench isolation, such as a silicon oxide film) having unevenness on a surface thereof.

With current ultra-large scale integrated circuits, having increased packaging density, CMP technology has become more important for fully smoothing (e.g., planarizing) a layer, especially for performing shallow trench isolation by, e.g., planarizing a silicon oxide layer filling the trench. With conventional CMP technology for planarizing a silicon oxide layer in forming shallow trench isolation, technical problems arise in that a high-level of smoothing can not be realized over an entire surface of a wafer, as described in the paragraph bridging pages 2 and 3 of Applicants' specification.

Against this background, Applicants provide a CMP abrasive capable of polishing an inorganic insulating film surface to be polished (such as a silicon oxide or silicon nitride insulating film) having unevenness, at high speed, without causing scratches, while achieving a high level of smoothing, and which can be used in forming shallow trench isolation (e.g., smoothing an inorganic insulating film (such as a silicon oxide film) filling the shallow trench). Applicants have achieved these objectives with a CMP abrasive according to the present invention, which also has excellent storage stability. Applicants have found that by including an organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of the inorganic insulating film, having unevenness to be polished, this organic polymer containing at least one atom having an unpaired electron in the molecular structure, in a polishing abrasive also consisting essentially of, e.g., a dispersant and cerium oxide particles, and water, objectives according to the present invention are achieved. That is, an insulating film such as a silicon oxide film or silicon nitride film can be polished with a high speed and a high level of smoothness, without scratches, achieving a manufactured product, using the polishing, in a high yield. In addition, the CMP abrasive according

to the present invention has good storage stability. The CMP abrasive has good properties such that it can be used in shallow trench isolation formation. Note from page 24, line 31 to page 25, line 12, of Applicants' Specification.

Illustrative of the advantages achieved according to the present invention, attention is respectfully directed to the Examples and Comparative Examples on pages 13-24 of Applicants' Specification. As can be seen in the polishing speed ratios R_5/R_1 and R_3/R_1 in the Examples and Comparative Examples in the present Specification, these ratios were much closer to one for compositions according to the present invention (note Examples 1 and 2 on pages 13-21 of Applicants' Specification), as compared with polishing speed ratios for Comparative Examples 1 and 2 on pages 21-24 of Applicants' Specification. In particular, compare the polishing speed ratios for Examples 1 and 2, respectively set forth at page 18, lines 13-23 and page 20, line 26 to page 21, line 11; with the polishing speed ratios for Comparative Examples 1 and 2, respectively, at page 23, lines 7-20 and page 24, lines 13-20. As is clear from these Examples and Comparative Examples, unexpectedly better smoothing at higher polishing speeds, corresponding to polishing speed ratios closer to 1, are achieved according to the present invention, including the organic polymer recited in the present claims, as compared with the Comparative Examples. It is respectfully submitted that this evidence of unexpectedly better results must be considered in determining patentability of the present invention (see In re DeBlauwe, 222 USPQ 191 (CAFC 1984)); and, properly considered, it is respectfully submitted that this evidence of unexpectedly better results clearly supports a conclusion of unobviousness of the presently claimed subject matter.

Clearly, this evidence must be considered by the Examiner, in connection with any rejection under 35 USC §103. See Manual of Patent Examining Procedure (MPEP 716.01(a)), where it is stated that:

"Examiners must consider comparative data in the specification which is intended to illustrate the claimed invention in reaching a conclusion with regard to the obviousness of the claims".

It is emphasized that the present invention as claimed herein provides a CMP abrasive for polishing inorganic insulating films having unevenness on a surface thereof (e.g., projections and/or recesses on such surface), the abrasive including, in addition to, inter alia, cerium oxide particles, an organic polymer having an atom or a structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of this film to be polished, and containing at least one atom having an unpaired electron in the molecular structure. Through use of this abrasive, an inorganic insulating film having unevenness on the surface thereof can be polished, such that the unevenness is smoothed; and the CMP abrasive has properties that it can satisfactorily be used in the formation of shallow trench isolation.

Sachan, et al. discloses techniques for polishing and planarization of integrated circuit surfaces, particularly those comprising a metal, a barrier layer and an insulating layer. This patent is primarily directed to such polishing which attenuates removal of the oxide film during metal CMP. This patent discloses that by including one or more organic polymers which attenuate removal of the oxide film, the polymers having functional moieties interacting strongly with the silicon oxide surface so as to provide a protective layer that inhibits removal of the silicon dioxide film at appreciable levels, the metal and barrier layer can be polished without removal of the oxide film. Note paragraphs [0003] and [0013] - [0017] on pages 1

and 2 of Sachan, et al. This patent document further discloses that the slurries may optionally contain a dispersant, which dispersant can be anionic, cationic or nonionic. See paragraph [0019] on page 2 of this published patent application.

Initially, it is emphasized that Sachan, et al. is primarily concerned with polishing a metal layer while attenuating removal of the oxide film. In this regard, note that Sachan, et al. includes, inter alia, an oxidant to oxidize the metal, as well as a metal complexing agent. In contrast, according to the present invention an oxide film may be polished. It is respectfully submitted that Sachan, et al. would have neither taught nor would have suggested such abrasive or such additive as in the present claims, consisting essentially of the recited components.

Again, note that the composition of Sachan, et al., attenuates removal of the oxide film. Note, for example, paragraph [0006] on page 1 of Sachan, et al., disclosing that the removal rate of the underlying dielectric film "should be as low as possible"; and that the selectivity of the removal rate of the dielectric film (SiO_2) should be low (preferably less than 100:1). See also Table 2 on page 3 of Sachan, et al., showing that polishing rates of Cu and SiO_2 are lowered by adding poly-vinylpyrrolidone (in particular, that a lowering in the polishing rate of SiO_2 is remarkable). Note also paragraph [0026] on page 3 of Sachan, et al., disclosing that the addition of a component such as poly-vinylpyrrolidone (PVP) suppresses the silicon dioxide removal rate while not suppressing the copper removal rate. It is respectfully submitted that, contrary to the conclusion by the Examiner, Sachan, et al. would have taught away from such a CMP abrasive as in the present claims, having the property of polishing an insulating film having unevenness on a surface thereof, including the organic polymer having an atom or structure capable of forming a hydrogen bond with a hydroxyl group present on a surface of this inorganic

insulating film having unevenness on a surface thereof, or wherein the abrasive has the property of being capable of being used in forming shallow trench isolation (where it would polish (e.g., flatten) an insulating fill material in the trench).

The contention by the Examiner on page 2 of the Office Action mailed September 11, 2006, that Sachan, et al. discloses a composition "consisting essentially of" components in the present claims, is respectfully traversed. It is respectfully submitted that the expression "consisting essentially of" is a term of art in the patent law, having a meaning of excluding materials affecting the basic and novel characteristics of the claimed invention. See In re Janakirama-Rao, 317 F. 2d 951, 137 USPQ 893 (CCPA 1963). Note MPEP 2111.03. Properly construing the language of the present claims, including the "consisting essentially of" language, it is respectfully submitted that Sachan, et al., disclosing a composition including, inter alia, an oxidizing agent and a metal complexing agent, for metal CMP, and would have neither taught nor would have suggested the CMP abrasive having the property of polishing an inorganic insulating film having unevenness on a surface thereof, consisting essentially of the recited components. Again, emphasizing that Sachan, et al. discloses that the removal rate of the underlying dielectric film should be as low as possible, relative to polishing of the metal and barrier layer, while the present CMP abrasive is for polishing the inorganic insulating film, it is respectfully submitted that Sachan, et al. would have taught away from a composition consisting essentially of and, more particularly, consisting of, the components as in the present claims.

The contention by the Examiner that the exact adsorption ratios and amount of organic polymer, and sedimentation speed, "would have been obvious matters of choice to one having ordinary skill in the art at the time the invention was made", set forth in the paragraph bridging pages 3 and 4 of the Office Action mailed September

11, 2006, is respectfully traversed. Initially, the Examiner has not shown that the applied references show that the various parameters are result effective parameters; thus, the Examiner has not established motivation for modifying the composition of Sachan, et al. to come up with compositions having various parameters as in the present claims. Particularly in view of advantages achieved by the present invention due to adsorption ratios and amount of organic polymer, and sedimentation speed of the cerium oxide particles, as described in Applicants' original specification, it is respectfully submitted that the Examiner clearly errs in his conclusion as to "obvious matters of choice", without any evidence in support thereof. See In re McKellin, 188 USPQ 428 (CCPA 1976).

It is respectfully submitted that the additional teachings of the applied Japanese Patent Document No. 10-102040 would not have rectified the deficiencies of Sachan, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

No. 10-102040 discloses a cerium oxide abrasive, which is a slurry prepared by dispersing cerium oxide particles containing specific primary particles in a medium. This patent document discloses dispersing in a medium such cerium oxide particles having a profile with corners less than 120° in angle, accounting for 90 wt.% of the total particles. This patent document further discloses that the medium is water, with a dispersant which is at least one kind selected from water-soluble organic polymers, water-soluble anionic surfactants, water-soluble nonionic surfactants and water-soluble amines. Note the English-language abstracts of No.10-102040.

Initially, it is noted that the applied Japanese patent document is directed to an abrasive for grinding a surface to be ground "such as of electric insulating film";

while Sachan, et al. is directed to a composition for polishing in metal CMP, wherein there is weakened polishing of an insulating layer (such as SiO₂). It is respectfully submitted that one of ordinary skill in the art concerned with in Sachan, et al. would not have looked to the teachings of the applied Japanese patent document, teaching a function and results directly contrary to that of Sachan, et al. In this regard, it is respectfully submitted that in modifying the teachings of Sachan, et al. in light of the teachings of the applied Japanese patent document, as applied by the Examiner, such combined teachings would have destroyed Sachan, et al. for its intended purpose. In view thereof, clearly the combination of teachings of the applied references is improper. See In re Ratti, 123 USPQ 349 (CCPA 1595).

In addition, it is emphasized that the teachings of the applied Japanese patent document utilize a water-soluble organic polymer, used as a dispersant. Comparing the teachings of the applied Japanese patent document and of Sachan, et al., and were such teachings to be properly combinable, it is respectfully submitted that the combined teachings of these references would have neither disclosed nor would have suggested, and in fact would have taught away from, an abrasive as in the present claims, having the organic polymer as recited therein, providing an abrasive for inorganic insulating films; and, in particular, wherein such abrasive utilizing such organic polymer is capable of being used in forming shallow trench isolation, and is adapted to polish an inorganic insulating film having unevenness on a surface thereof, as in the present claims. In this regard, Sachan, et al., polishing metal without polishing the inorganic insulating film, includes the polymer, while the applied Japanese patent document, polishing an inorganic insulting film, includes a water-soluble polymer, as a dispersant.

The contention by the Examiner in Item 7 on page 4 of the Office Action mailed September 11, 2006, that it would have been obvious to one having ordinary skill in the art at the time the invention was made to remove components from the CMP abrasive of Sachan, et al. in order to polish insulating films, the Examiner relying on the teachings of the applied Japanese patent document, is respectfully traversed. It is emphasized that the purpose of Sachan, et al. is to polish metal selectively, relative to the insulating film. It is respectfully submitted that by omitting certain components of the composition of Sachan, et al., as alleged by the Examiner, Sachan, et al. would have been destroyed for its intended purpose. In view thereof, clearly the modification proposed by the Examiner, destroying Sachan, et al. for its intended purpose, is improper. See In re Ratti, supra.

It is respectfully submitted that the Examiner must look to the teachings of Sachan, et al., without benefit of the teachings of the present application. It is respectfully submitted that the Examiner has, improperly, made hindsight use of Applicant's disclosure in coming to a conclusion of obviousness of removing components from the composition in Sachan, et al. That the Examiner has used improper hindsight in coming to a conclusion of obviousness is especially seen in light of the purpose of the teachings of Sachan, et al., to provide a polishing composition for a metal layer with attenuation of removal of the oxide film (that is, a removal rate of the underlying dielectric film being as low as possible). Properly using the teachings of Sachan, et al. as a whole, as required under 35 USC §102 and 35 USC §103, it is respectfully submitted that Sachan, et al. would have neither taught nor would have suggested the presently claimed CMP abrasive having the property of polishing inorganic insulating films having unevenness on a surface thereof, consisting essentially of the components recited in the present claims.

Taking the teachings of Sachan, et al. as a whole, as required under 35 USC §103, it is respectfully submitted that Sachan, et al. teaches the reduction in the removal rate of the insulating film, and attenuation of removal thereof. It is respectfully submitted that this would have taught away from use of the composition of Sachan, et al. "to polish an oxide film", as alleged by the Examiner. It is respectfully submitted that only through hindsight use of Applicant's disclosure would one of ordinary skill in the art have either removed components of the composition of Sachan, et al. for polishing of an oxide film, or have used the composition of Sachan, et al. to polish an oxide film in the absence of a metal film. Clearly, such hindsight use of Applicant's original disclosure is improper, under the guidelines of 35 USC 103.

The contention by the Examiner in the first full sentence on page 5 of the Office Action mailed September 11, 2006, that one having ordinary skill in the art would choose the various variables "to produce a desired result in a method of using the abrasive/additive", is noted. It is also noted that the Examiner has pointed to no evidence or reasoning that one of ordinary skill in the art would have selected "these variables", much less that one of ordinary skill in the art would have selected these variables "to produce a desired result". In light of silence in the teachings of these references that the variables are "result effective variables", and also in light of advantages achieved by the present invention due to variables within the range in the present claims, as described in Applicants' specification, it is respectfully submitted that the conclusion by the Examiner of obviousness with respect to the presently claimed ranges of the recited variables, without any basis in evidence or reasoning in support thereof, is improper.

Contentions made by the Examiner on page 6 of the Office Action mailed September 11, 2006, are noted. With respect to the first point raised by the Examiner, the Examiner's attention is respectfully directed to newly added claims 33 and 34, further defining the film which the abrasive is adapted to polish (that is, defining the property that the abrasive is adapted to polish an oxide insulating film having unevenness on a surface thereof, or is adapted to polish a silicon oxide film having unevenness on a surface thereof).

In addition, the Examiner is respectfully requested to point out the specific portion of Sachan, et al., disclosing that the compositions therein are capable of polishing silicon nitride or other non-oxide insulating films.

The additional contention by the Examiner that Sachan, et al. "is also capable of polishing an oxide film, even if it may be ever so slightly", is noted. This is directly contrary to the teachings of Sachan, et al., directed to reducing polishing of the oxide film. Clearly, Sachan, et al. would have neither taught nor would have suggested such abrasive as in the present claims, having properties of being capable of being used in forming shallow trench isolation, and being adapted to polish an inorganic insulating film (more specifically, an oxide insulating film or silicon oxide film) having unevenness on a surface thereof.

The additional contention by the Examiner on page 6 of the Office Action mailed September 11, 2006, that Applicants' unexpectedly better results "are based mainly on processes of using the CMP abrasive for a specific purpose of polishing an inorganic insulating film having unevenness on a surface thereof", and that the "process claims are not being examined on the merits", are noted. It is respectfully submitted that Applicants' unexpectedly better results are related to properties of the

CMP abrasive, as in the present claims; and it is respectfully submitted that these properties must be considered, in determining patentability.

In connection with unexpectedly better results achieved according to the present invention, attention is respectfully directed to Table 2 on page 3 of Sachan, et al. This Table 2, in connection with Example 2 in paragraph [0025] of the reference, shows that the removal rate (polishing rate) of silicon oxide is suppressed 1/10 by adding poly-vinylpyrrolidone. It is respectfully submitted that Sachan, et al. would have taught away from the presently claimed invention, including an abrasive consisting essentially of the recited components and having properties including, inter alia, wherein the abrasive is capable of being used in forming shallow trench isolation, and is adapted to polish an inorganic insulating film having unevenness on a surface thereof, more specifically, being adapted to polish an oxide insulating film or silicon oxide film having unevenness on a surface thereof.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently pending in the above-identified application are respectfully requested.

To the extent necessary, Applicants hereby petition for an extension of time under 37 CFR 1.136. Kindly charge any shortage of fees due in connection with the filing of this paper, including any extension of time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Account No. 01-2135 (case 511.40998X00), and please credit any overpayments to such Deposit Account.

Respectfully submitted,

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